# Collider Super-Table for a Modern Hadron Collider

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## *Introduction*

A super-table is a spreadsheet that is used to describe the performance of high energy colliders. The columns of the super-table are major parameters that describe the collider performance such as peak luminosity, integrated luminosity, intensity, emittance, etc. The rows of the super-table display the values for a given collider store. The primary users of the super-table are accelerator physicists, experimenters, and major system managers. The super-table gives these people a general overview of how the collider is performing and where the major bottlenecks to collider performance occur. The super-table is of most use when the collider is in routine operations and the collider configuration is not changing drastically from store to store such as occurs during the initial commissioning period.

The most important characteristic of a collider's performance is phase space density. To present a general overview, the super-table must present this information clearly and not obscure the information by recording an overwhelmingly large amount of parameters. Therefore, the super-table is not intended for use by accelerator operations experts to diagnose specific or detailed accelerator problems.

## *Super-Table Parameters*

The super-table parameters are broken into two major groups, global parameters and state dependent parameters.

### Global Parameters

A reasonable list of global parameters are:

1. Store identification number
2. Date and time when store began
3. Duration of the store
4. Shot setup time –the length of time it took the collider to be filled
5. Recovery time – the length of time it took the collider to recover from the previous store
6. End of store cause such as a quench, an abort, or normal termination
7. Initial peak luminosity averaged over a number of detectors
8. Luminosity lifetime
9. Integrated luminosity averaged over a number of detectors
10. Number of bunches in each beam

### State Dependent Parameters

State dependent parameters are parameters that change during the store such as the bunch intensity and the transverse and longitudinal emittance. A modern hadron collider will contain a large number of bunches. Instead of recording the parameter data for each bunch, it will be much simpler and clearer if only the average parameter value per bunch and the statistical variation (or standard deviation) from the average of the parameter value will be recorded.

## *Super-Table State Transitions*

For simplicity, the super-table should record data at limited number points in time during the store. These points of time can be thought of as accelerator state transitions. Examples of state transitions are Injection, Initiate Collisions, etc... Because luminosity density is a slowly varying quantity, the coarseness of the data acquisition resolution can be very rough. It is likely that the super-table can use data already acquired by other data loggers so that no other data acquisition system is needed. The states along the ramp that are of most interest are:

1. Injection
2. Beginning of Ramp
3. End of Ramp
4. Initiate Collisions
5. End of Store.

## *Super-Table Views*

Even limiting the number of super-table columns to a few global and state-dependent parameters can be difficult to display clearly if one takes into account the number of state-transitions and number of beams in a collider. Instead of organizing all these parameters into one large super-table, it would be clearer to organize the super-table as a number of hierarchical sub-tables. Also it would be convenient to have each sub-table to be sorted by different criteria such as all of the stores, the last ten stores, and the best ten stores.

At this point, one might be tempted to develop a general viewer tool that would permit the viewer to describe how the user would like the table to be displayed. However, it should be kept in mind that the primary users (physicists, engineers, and managers) of these tables might not be an expert at using such a general tool so the first incarnation of the super-table should have simple pre-defined views. A reasonable set of pre-defined views would be:

1. Level 1 View: Global parameters and average phase space density parameters at the state transition of Initiate Collisions.
2. Level 2 View: Global parameters and average phase space density parameters at all super-table state transitions.
3. Level 3 View: Global parameters and both average and deviation from average of phase space density parameters for each beam at all super-table state transitions.

An example of a set of hierarchical sub-tables using fake data, can be found at:

http://www-bdnew.fnal.gov/hq/mcginnis/fidosupertable/FidoSuperTable.html